Mindsurf Networks

Schools of Innovation
Evaluation Overview

CCT Reports
July 2001

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Introduction

Mindsurf Networks aims to provide portable computing and Internet access to students and teachers through wireless networking, handheld computers, software, and support, moving away from the prevailing strategy that including technology in public schools involves placing wired, desktop computers in a lab environment. The cornerstone of Mindsurf Network’s approach is one-to-one computing: every student and teacher should have immediate and individual access to a rich array of information resources. By providing students and teachers with information and communications technologies that are portable but have the capacity to store several electronic books — as well as spreadsheet and word processing software, a personal calendar, email and infrared communications functionality, Internet connectivity, and a bevy of other resources — the company hopes to achieve four goals:

• Provide teachers with the means for frequent assessment of student work, provide students with ready feedback;
• Help teachers tailor their instruction to students’ needs;
• Offer high-quality instruction and interaction for all; and
• Support effective classroom management.

Prior to entering the educational marketplace and selling its commercial solution to schools and districts, the company formed partnerships with two “Development Schools” in Maryland — a high school located in an affluent suburb in Howard County and an urban middle school in Baltimore — and 84 “Schools of Innovation” scattered throughout the country. At the two Development Schools, where multiple teachers are experimenting with the handheld wireless tools, Mindsurf has been conducting extensive beta testing of its prototypes and overall approach to wireless computing. Additionally, Mindsurf has been using the Schools of Innovation (SOIs), which are located in urban, suburban and rural middle and high schools in 26 states, to test their network solution on a broad scale.

In order to become a School of Innovation, Mindsurf asked schools considering participating in its SOI Program to sign a Memorandum of Understanding (MOU). The MOU detailed the vision, scope and incentives of the program and clarified the responsibilities of the company and the participating schools. Beginning in February 2001, Mindsurf Networks began providing each SOI with the following:

• a class set of handheld, wireless computers, each provisioned with a variety of wireless software applications;
• one wireless access point to be linked to the school’s existing, qualified LAN;
• training for the pilot teacher;

1 See Appendix A for a sample of a Memorandum of Understanding.
2 Mindsurf Networks recruited schools on a rolling basis; consequently, some of the schools became an SOI in March and April 2001. Also, one teacher at one of the Development Schools has been working with company prior to the launch of the SOI Program.
3 The company defined a class set as no more than 30 handheld computers.
• on-going technical and curriculum support for the duration of the pilot; and
• a written summative report of results.

SOIs will continue to use the materials that Mindsurf Networks has provided and will participate in the Program until it formally concludes in December 2001.4

For the Spring 2001 semester, teachers and administrators at each SOI selected the class in which they would use their set of handheld computers.5 Consequently, SOI participation involved a variety of subject areas (e.g., Language Arts, Science, Mathematics, and Social Studies); a number of grade levels (seventh through twelfth); and a range of student levels (e.g., Gifted and Talented, Honors, General Education, Special Education and Learning Disabled). The schools also were free to implement the technology as they thought best. For example, they could choose to provide students with handheld computers that students could use throughout the school day and take home; they could provide students with access to the handheld computers during class time only; or, they could create a “class set” of handheld computers, allowing several classes to use and share the tools. To support the effective use of the handheld computers and wireless network, Mindsurf Networks also provided a Web site with online resources for both students and teachers. The Web site includes a Teaching Exchange — a collection of lesson plans and teaching methods that teachers can adapt to their own classes, along with profiles of teachers and how they have used the handheld computers in their classes.

To understand better the Schools of Innovation Pilot Program, the experiences of the Development Schools, and the overall potential of the Mindsurf tools, the company commissioned the Education Development Center’s Center for Children and Technology (CCT) to conduct an evaluation. CCT, a non-profit organization that has been studying the roles that technology can play in teaching and learning for the last 20 years, devised a research plan that includes a five-month formative evaluation, from February to June, 2001, of the ways teachers and students at the Development Schools and SOIs use the Mindsurf applications. This report is the culmination of that formative evaluation. As an outgrowth of this report, CCT is engaging in consultation with Mindsurf Networks around the implementation of this report’s recommendations and the roll out of version 2.0 of the company’s product line.

For the formative evaluation, CCT examined the kinds of applications that have been available to students and teachers, for what purposes they have been used, their perceived benefits, and the challenges that teachers and students faced in using them. This examination allowed us to suggest potential improvements, enhancements, or additions that would strengthen the tools in the company’s future offerings to schools. The perceived and potential benefits are discussed in detail in Section III. SOI teachers and students also encountered a number of challenges while integrating the Mindsurf tools into their classroom experiences, as is true for all technology pilot implementations.

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4 At the conclusion of the SOI Program, the company will permit some of the schools to keep the hardware they received while other schools will return the equipment to Mindsurf Networks.

5 Some of the SOIs also are using their set of handheld computers during summer school.
These challenges ranged from issues involving technical infrastructure and hardware to tool management to classroom practice.

CCT utilized a variety of methodologies — site visits, interviews, classroom observations, and a Web-based survey — to assess how participating teachers and students use, understand, and leverage the MindSurf Network tools. In addition, CCT collected a range of contextual data that helped us in undertaking a preliminary analysis of the ways in which different types of schools use different applications.

This report presents profiles of the schools, teachers, and students involved with this project, the uses that teachers and student made of the Mindsurf tools, the potential benefits to teaching and learning that the data suggest, and several case studies of the Mindsurf tools in context.
Section I. Profiles of Schools, Teachers and Students

By Mindsurf Networks’ design, the schools that the company selected to participate in the Schools of Innovation program and to serve as development schools were diverse. All of the SOIs went through a similar implementation process — signing a Memorandum of Understanding, setting up a wireless access point at their school, sending a teacher for training, and “rolling out” the tools with the students — but teachers and administrators at each SOI had the freedom to decide how best to use the Mindsurf tools within their individual schools. As a result, the SOIs developed very different uses for the Mindsurf tools. This section will present profiles of the SOIs, teachers, and students. The following section will present how these schools used the Mindsurf tools.

We employed a variety of quantitative and qualitative research data in order to profile the SOIs. The findings we present below are culled from responses to a Web-based survey that we distributed to all 84 SOIs (51 were returned), observations from 30 site visits, and interviews with teachers, administrators, students and parents.

SOI Schools

The data we collected present a complex and varied image of the SOIs. Demographically, these schools represent a range of regions, school levels, subject areas, grades, and socio-economic levels. In terms of pedagogy and professional development, the survey responses indicate that there is a smaller range of variation, as the majority of the SOI teachers described environments that are supportive of teaching and learning.

Location

Although most of the SOIs are located in urban and suburban areas — 41 and 45 percent respectively, with the remaining 14 percent in rural areas — there is considerable variation in terms of school location. The 30 SOIs ranged from that of an urban school with metal detectors, barred windows and 30 security guards in the hallways at all times to that of a suburban/rural school with state-of-the-art technology, a community arts center, swimming pool and tennis courts. We visited schools located in city apartment buildings; schools flanked by grassy football and soccer fields; and schools across from the Wal-Mart on the outskirts of bedroom communities. We went to schools in warm climates with open campuses, which allowed teachers to plan outdoor activities, and schools in cold climates, where students spent their days inside the heated building. We saw some schools attended by several generations of the same family, and others with high transient rates. Each school represented a unique context.

Professional atmosphere

Overall a supportive institutional culture for teachers exists within the majority of the SOIs. In the survey, a high percentage of teachers indicated that before the implementation of the Mindsurf Networks tools, they either “sometimes” or “often” discuss student learning goals (76 percent); talk about the integration of technology into the curriculum (63 percent); share samples of student work at staff meetings (37 percent); use student learning data to modify instruction (82 percent); and, plan lessons and curricula with colleagues (70 percent). While on site visits, we observed several
indicators of school culture. At some schools, we walked through school hallways adorned with student work and lined with display cases, showcasing trophies and plaques that highlighted students’ achievements. We also interviewed several administrators who communicated that one of their school’s priorities was integrating technology into the curriculum. We met teachers who worked in interdisciplinary teams to plan lessons. Interestingly, several teachers reported that the SOI Program, because of its single-classroom model, did not allow for the kind of collaboration that they may have experienced in other school-wide reforms.

**Technology infrastructure**
The technology infrastructure and support network within the SOIs varied greatly. In approximately one-third of the SOIs, we observed advanced information and communications technologies, as well as a supportive, well-trained human infrastructure. They included fiberoptic connectivity, new computer labs, and a full-time technology coordinator. Most of these schools had established rich sources of funding in conjunction with a coherent technology plan that was central to the school’s mission. Other schools that we observed were less well-equipped. In these cases, there may have been one or two old computer labs that the teachers seldom used; the rare on-site technology workshop; no building-level technology support person; and, perhaps a district technology coordinator, who was not based at the school and occasionally came to the school site to repair broken-down equipment.

**Integration of Mindsurf tools**
In the short time available to them, teachers used the Mindsurf tools intensively with their classes. Teachers used the tools frequently; thirty-seven percent of the survey respondents reported using the tools every day, and another 39 percent reported using them between three and four days a week. The amount of time teachers used the tools during a particular class period varied widely; teachers reported using the tools between 25 and 100 percent of the entire class period, suggesting that the teachers integrated the tools with the traditional class work in a variety of ways. Because of the differences relating to the schools’ technology infrastructure, some schools were able to provide more support for the Mindsurf tools than other schools. At many schools, technology-specific personnel were available to problem-solve when needed. One teacher informed us that the technology coordinator resolved a problem with network connectivity in time for the next period. Another teacher, without the assistance of an on-site technology coordinator, spent several days running back and forth between his classroom and the central office to call Mindsurf’s support telephone number while trying to solve a network problem. Typically, the option for teachers without on-site support was the Mindsurf 800 number. This posed difficulties as few teachers have access to telephones in their classrooms.

Beyond basic functionality and troubleshooting, the school’s infrastructure influenced the effective use of the Mindsurf tools. Slow district networks made for slow access in the Mindsurf classroom. For example, we observed a middle school classroom where as many as seven students could not connect to the network when the entire class was trying to get on-line at the same time. In other classrooms, finding enough outlets to recharge all
of the students’ handheld computers was so much of a challenge that the school had to install new outlets specifically for that purpose.

For those schools with a solid technical and human infrastructure, SOI teachers were able to leverage the Mindsurf SOI program from the outset. In some schools, the program brought with it prestige. Some SOIs publicized the incorporation and implementation of handheld computers in the classroom, believing that the project had the potential to attract students to their school. Administrators at these schools reported that the wireless, handheld model had become part of their technology vision and was a model they wanted to adopt as part of their technology plan.

**SOI Teachers**

Many of the teachers reported that they were asked to participate in the SOI program because they were known as “cutting edge” teachers, teachers with dynamic pedagogy, or teachers to approach when something needs to get done.

*Technology experience and comfort level*

Many of the SOI teachers were known within their schools and sometimes districts for their interest in educational technology prior to participating in the SOI Program. In the survey, over two-thirds of the respondents indicated that they were a source of technology leadership at their school. Two-thirds reported that they also looked to the school technology coordinator for leadership. In general, though, teachers indicated that several people were responsible for technology leadership at their school; in addition to themselves and the school technology coordinator, this included other teachers, the Principal or administration, and the district technology office.

These teachers were generally comfortable with the use of technology. Over 90 percent of the respondents characterized their familiarity with the technology as “fairly comfortable” or “expert,” and 57 percent rated themselves as “very comfortable” to “expert,” far above the national average of 33 percent. Only three teachers rated themselves as “novice.” When visiting schools, we met teachers who fell all along the continuum from those who knew how to utilize basic software programs to those who experimented with more advanced programming. Several teachers received support from the technology coordinator or were able to collaborate with another teacher who was involved in the project. However, due to the SOI model, which provides the Mindsurf tools for a single teacher at a school, many teachers also felt that they were left alone to implement the project at their site.

*Teaching experience*

The SOI teachers were comprised of both new and veteran teachers. These teachers had been teaching less than three years (10 percent), between three and 10 years (35 percent), between 11 and 20 years (27 percent), and over 20 years (25 percent). Overall, this is a

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7 Because percentages in this report are rounded off, they may not add up to 100 percent.
slightly less experienced teacher population compared to the national breakdown, which is 10, 26, 35, and 30 percent, respectively. During site visits and at the training sessions, we met teachers who represented a range of years, from first-year uncertified teachers to those who had been teaching the same subject for over 30 years. The number of years of experience did not influence the degree of familiarity with technology that they reported.

**Classroom practice**
In general, the SOI teachers are pedagogically progressive. Most survey respondents reported that they often assigned cooperative learning activities (61 percent), assigned independent or group research projects (51 percent), engaged in more than one activity in the classroom at one time (51 percent), developed individualized lesson plans (63 percent), or used curricula that they or a colleague had developed (59 percent). During our site visits, we observed multiple teaching philosophies, styles, and pedagogy. We saw teachers assigning group projects, instructing students to work in pairs, utilizing performance and authentic assessments, implementing cooperative grouping strategies, aligning curricula with standards, and modifying lessons for individual students and students with Individualized Education Plans (IEP). The progressive teaching practices we generally observed are the kinds of constructivist teaching practices that researchers Hank Becker and Margaret Riel correlate with practices associated with teacher leaders. In addition, they found that “cutting edge” teachers, such as many of those involved in the SOI Program — teachers who tended to be more extensively involved in professional activities — were more likely not only to engage in constructivist teaching practices, but also to use computers “more and in exemplary ways.”

**Attitude toward SOI Program**
Most of the teachers were enthusiastic about the project. Typical was the comment of one teacher, written in the SOI survey: “This is cutting edge and I am sure it has a great ever expanding future!” Several teachers spoke emotionally with us about the opportunity these tools presented for their own professional development, as well as for their students learning. Many were excited by the potential of the handheld computers to foster more sophisticated learning skills in their students, including higher-order thinking skills, detailed writing, and more self-directed learning. Although some teachers reported frustration with the Mindsurf tools, as we describe in the “Common Challenges” section, this frustration most often was tied to technical problems. As one SOI teacher commented in the survey, “The whole thing has been difficult. My kids don’t even want them because of some of the problems we’ve encountered.” Representative of a small minority of teachers’ attitudes, this sentiment represents the exception, not the rule.

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SOI Students
Students from many different age levels, academic abilities, and geographic locations used the Mindsurf Networks tools during the spring of 2001. There was a combined total of 1640 students in the 51 SOI teacher survey respondents’ classrooms.

Class size
According to the SOI survey, the number of students, associated with a single teacher using the handheld computers, ranged from as few as 12 to as many as 110. The mean was 32 students per teacher. This most likely does not represent the number of students in one class as a few teachers used a class set of handheld computers with several classes. Teachers that did use class sets provided a number of students, ranging from 70 to 110, with access to the handheld computers. The classes we observed ranged from three to 38 students. Although it is difficult to know which of the numbers in the survey represented individual classes and which reflected the use of class sets, most respondents reported that the number of students they taught was in the high 20s to low 30s. These numbers are higher than the national average, which is 24 secondary school students per class.\(^\text{11}\)

Grade level
The grade levels taught by the SOI teachers using the Mindsurf Networks tools ranged from the fifth to the twelfth. According to the survey respondents, 21 percent of the teachers taught the eighth grade. Seventeen percent taught seventh grade, and 17 percent taught grades nine through twelve. Only one respondent indicated that he or she used the handheld computers with a fifth grade class. We visited a total of 17 middle schools, ten high schools, and three schools that housed a mix of both middle and high school students.

Ethnicity
Students from a wide range of ethnicity participated in the SOI program. According to the SOI survey, 31 percent of the students were white (not of Hispanic origin), 27 percent African-American, 20 percent Hispanic, 15 percent Asian or Pacific Islander, and 4 percent American Indian or Alaskan Native. There also were one or two students who were Indian, Somali or Middle Eastern. From our school visits we observed that some individual classes were racially mixed. For instance, in one middle school in the midwest 84 percent of the students were of color, including recent immigrants from Somali and Mexico as well as third- and fourth-generation African-Americans and Caucasians. On the other hand, other SOI classes were almost entirely White, African-American or Hispanic with very little diversity.

Subject areas
Students in SOI classrooms were engaged in a number of disciplines. According to the SOI teacher survey responses, the subject areas in which the Mindsurf tools were used were as follows: English/language arts (20 percent), science (18 percent), social studies/social sciences (15 percent), mathematics (12 percent), and history (10 percent). During our site visits, in addition to observing classes in the above disciplines, we

\(^{11}\) http://nces.ed.gov/pubs2001/digest/dt069.html
encountered classes that fall outside of core requirements: Journalism, French, Spanish, and World Geography. Additionally, in several schools, particularly on the middle school level, SOI teachers supplemented the subject-area work that the students were doing with lessons in keyboarding. This occurred both inside the SOI classroom as well as during “tech skills” and “keyboarding” classes.

**Student level**
Although SOI teachers most often selected “general education” (31 percent) in response to the survey question that asked about student level, there was also a high percentage of teachers that selected “honors” (19 percent) or “gifted and talented” students (22 percent). “Special education” and “second language learner” each comprised between seven and eight percent of the population. Our school visits also gave us an opportunity to observe students at many different levels. One site was a facility serving emotionally and behaviorally disturbed children. The goal at this site was behavior modification; the seven SOI students, ages 13-16, took classes in behavioral and social skills before being returned to their regular schools.

**Student attitudes toward SOI program**
Students were almost uniformly positive and excited about using the handheld computers. Many said that they felt privileged being the ones the school selected to use the Mindsurf tools. Others talked about the pressure of being responsible for the handheld computers and about their desire to live up to their teachers’ expectations. Student attitudes toward the handheld computers correlated with different elements of the student population. Many honors and gifted students appreciated the handheld computers as useful tools, but did not see them as transforming the kind of student they are. As one student explained, “It doesn’t [make me a better student]…. It’s not thinking, just putting our thoughts into it.” Learning disabled and general education students, however, reported that the handheld computers have opened up their education in new ways, as we will discuss in greater detail in the “Potential Benefits” section.

<table>
<thead>
<tr>
<th>Development Schools</th>
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<td>In addition to the SOIs, Mindsurf Networks purposively selected two development schools – River Hill High School and Hamilton Middle School – where they could conduct a more in-depth, sustained observation of the tools across a series of variables. Unlike the SOI model, the school chose five “pioneer” teachers, all of who teach a different subject, to pilot the program in their classrooms. The five teachers have been working together at the school site (River Hill since mid-February 2001 and Hamilton since the beginning of April 2001) with the support of a Mindsurf Networks representative to integrate the tools into their instructional programs.</td>
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</table>

The two schools represent markedly different contexts in terms of location, environment, socioeconomic status, racial demographics, student achievement, class size, resources, and school performance. River Hill High School is located in a suburb of Howard County. For the 2000-2001 school year, River Hill enrolled approximately 1600 students in grades nine through twelve, the majority of who are from white, upper-middle class
families. At River Hill, students attend various classes with different groupings of students throughout the day, and the average class size is 20. River Hill has been recognized as the only high school in the state of Maryland to receive outstanding ratings in all areas of the state report card. Unlike River Hill, Hamilton Middle School is an urban, minority school serving approximately 1100 students in the sixth through eighth grades. Ninety-five percent of the students are African-American, and 75 to 80 percent are eligible for free or reduced lunch. In average class sizes of 38, the students move together in cohesive groups all year long. In 1997, Hamilton was labeled a Reconstitution Eligible School by the state of Maryland because students’ standardized test scores were exceptionally low. If the school is not able to improve test scores by 2002, the state will take it over.
Section II. Uses of the Mindsurf Networks Tools

As stated in the previous section, teachers and administrators at each SOI had the freedom to decide how best to use the Mindsurf Networks tools within their individual schools. The result: we observed, and the Web survey bore out, a wide diversity of classroom use. We observed uses that related to tool management, teachers’ instructional use, and the students’ formal and informal uses of the tools.

### Tool Management

This area includes a discussion of the length of time SOI teachers and students were using the Mindsurf tools as well as a number of issues that arose around general tool management, such as storage and charging.

**Length of tool use**

SOI teachers did not have a lot of time to use the Mindsurf tools during the Spring 2001 school semester. When teachers completed the survey, most schools had been using the tools for between four and eight weeks (51 percent), although some schools had been using them for more than 10 weeks (22 percent) or less than four weeks (14 percent). During that time, most teachers used the tools intensively. The teachers reported that they were using the tools more than three days a week (76 percent), and used them for anywhere from a quarter to the entire class time. As a result of the short, intensive period of use, the teachers tended to have an experimental attitude toward how to use the Mindsurf tools. During our site visits, teachers often mentioned that they were trying something new that day, and many of the uses we observed had only been tried with the class three or four times before. This attitude of experimentation led to different reactions to the project; when we first contacted schools to discuss the possibility of a visit, some teachers were resistant because they felt that they had not had sufficient time to integrate the tools into their classroom practice and simply wanted more time. Likewise, several SOI teachers remarked that they look forward to the summer and the opportunity to experiment with and prepare to fully implement the tools beginning in the fall of 2001.

**Storage and Charging**

Schools and teachers faced several decisions concerning the management of the Mindsurf tools, including how to manage both the storage and charging for the handheld computers. A major consideration in tool management was whether to allow students to take the handheld computers home. Roughly half of the teachers reported either that the students kept the handheld computers in the classroom or that the students could or must take the handheld computers home. We visited schools where students only used the handheld computers in the classroom, schools where students decided which computer and peripheral equipment, if any, to take home, and schools where students checked out their handheld computer from the classroom to take home at the end of the day.

Storage and charging were also major factors in determining handheld computer use. Teachers developed a range of strategies for storing and charging the handheld computers. They secured the handheld computers and peripherals in metal cabinets or closets in the classroom, on rolling carts, on back tables, and in other rooms. Regarding
charging, 30 of the 51 survey respondents reported that the students were responsible for charging the handheld computers, while 14 reported that they were responsible for charging. Half of the survey respondents reported that the handheld computers were both charged and stored in the classroom, while only 11 reported that they were charged or stored outside the classroom.

During our visits to SOIs, we observed classes where storing and charging the handheld computers took time and effort. We saw classes where students lined up to get their handheld computers and peripherals, classes where students passed out equipment to the class, and classes where handheld computers were placed wherever there were electrical outlets, including on the floor. We also saw classes where storage and charging did not interfere with class time or space. For some, strategies for tool management presented (sometimes major) challenges for classroom management.

### Teachers’ Instructional Use

SOI teachers used the Mindsurf tools in many ways. They used the handheld computers primarily for preparing written assignments, personal organization, and distributing and collecting handouts via infrared beaming. Other major uses included Web research for lesson development, providing written feedback to student work, and syncing. In general, teachers reported a wide range of uses, each reporting an average of seven items on the survey (see Figure 1). This is consistent with our site visits and interviews with teachers, during which teachers often spoke enthusiastically about their own experiences and discoveries using the handheld computers.

Because most schools had only four to eight weeks to use the Mindsurf tools, all of the teachers we observed were experimenting with ways to use them and had yet to settle into a routine. Many teachers modified traditional lessons to incorporate the handheld computers. Many of the more commonly used activities — word processing, online research, note taking, collaborating on writing assignments, completing homework, and...
Student Use

This area includes both students’ formal and informal use of the Mindsurf tools.

Students’ formal use of tools

Within the context of formal classroom instruction, students used the Mindsurf tools in many ways. Unsurprisingly, the survey indicated that the most common uses were word processing, online research, and note-taking, but many teachers reported a variety of student uses (see Figure 2). The survey provides a general breakdown of formal classroom use, but even within one category we observed a wide diversity of uses.

Considering word processing, for example, we saw students free-writing character sketches, writing descriptive paragraphs based on images, reorganizing notes from online research into organized paragraphs, working in groups to combine several students’ notes into a single report, posing questions onto another student’s writing in preparation for revision, writing letters from a literary character’s perspective, and recording field notes. Generally, major types of use — word processing, note-taking, online research, recording notes or presentations, and collaborating on assignments — occurred across subject areas. Some uses were reported to a greater or lesser degree according to subject area: Excel was less often reported as a use by English/language arts classes; peer editing, collaborative writing, Ereader use, and portfolio work, less often for computer and

Figure 2

Student Uses: Formal Classroom Instruction

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of Teachers</th>
</tr>
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<tbody>
<tr>
<td>Word processing</td>
<td>46</td>
</tr>
<tr>
<td>Online research</td>
<td>45</td>
</tr>
<tr>
<td>Note-taking</td>
<td>38</td>
</tr>
<tr>
<td>Recording notes or presentations</td>
<td>32</td>
</tr>
<tr>
<td>Collaborating on assignments</td>
<td>32</td>
</tr>
<tr>
<td>Emailing</td>
<td>28</td>
</tr>
<tr>
<td>Peer editing</td>
<td>27</td>
</tr>
<tr>
<td>Ereader: books/articles</td>
<td>21</td>
</tr>
<tr>
<td>Organizing work and/or portfolios</td>
<td>20</td>
</tr>
<tr>
<td>Developing spreadsheets in Excel</td>
<td>20</td>
</tr>
<tr>
<td>Annotations/highlighting in Ereader</td>
<td>12</td>
</tr>
<tr>
<td>Giving presentations</td>
<td>12</td>
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mathematics classes. The range of formal classroom uses generally did not depend on the teacher’s subject area. Although teachers in some subject areas reported a greater or lesser range of uses, history teachers averaged twice as many uses as computer teachers (16 as opposed to 8) - most subject areas reported between 10 and 12 uses in their classroom.

Informal student use of tools
Outside of formal classroom instruction, students discovered other ways to use the handheld computers. As part of the web survey, we asked SOI teachers to indicate how they thought their students were using the handheld computers outside of formal classroom instruction. Some of the most common uses were: recording voice and/or music (88 percent); visiting Web sites for class research (84 percent); studying (78 percent); visiting Web sites for the student’s own interests (78 percent); and, personal organization (77 percent). Many activities, such as those for outside work or activities, and for school-related events, were reported for “a few” students by many teachers (see Figure 3).

12 These percentages represent the sum of respondents who indicated that “a few” to “all” of their students engaged in these activities.
We correlated data on the formal and informal uses of the Mindsurf tools to data on demographics, characteristics of the SOIs, and the implementation of the Mindsurf tools. In general, the survey responses for formal and informal use of the Mindsurf tools were not linked to SOI location, number of weeks using the tools, or grade level. For example, teachers reported the same number of classroom uses regardless of grade level or how long they had been using the handheld computers. However, the lack of quantifiable trends between these factors and formal and informal uses does not mean that there were no differences in use in relation to these characteristics. For example, we observed word processing at many different grade levels, but naturally, the complexity of the writing process was different according to grade level.

We found a strong relationship between students who were allowed to take the handheld computers home and the range of both formal and informal handheld computer use. Teachers whose students took the handheld computers home reported over 75 percent more types of formal classroom uses than those whose students kept the handheld computers at school. Particular uses were also more common in classes in which students took the handheld computers home; completing homework assignments, collaborating on assignments, and Ereader activities were reported 50 to 100 percent more often in those classes.

The students who took the handheld computers home were more likely to engage in uses outside of formal classroom instruction than the students who did not take the computers home. The evidence demonstrates that students, who took the computers home, were 50 percent more likely to use the handheld computer for studying;\textsuperscript{13} five times more likely to use them for work or activities outside of school; three times more likely to use them for school-related events; and, three times more likely to use the handheld computers in other classes. However, the students who did not take the handheld computers home did find their own uses for the tools outside of formal classroom. Examples include chatting online in class, playing games, recording their friends’ voices, and emailing one other.

From our site visits and interviews, we observed that students who took the handheld computers home tended to explore a wider range of uses. One senior wrote articles for the school newspaper about a robotics competition in Disney World. He also installed Linux on his handheld computer to compare it to the CE operating system. When a group of middle school students planned a trip to New York for the same time that their science class was collecting local climatological data, their teacher suggested that they collect their data from New York and use it for comparison. One student used his handheld computer to communicate with the doctor with whom he was working at his hospital internship.

The students’ experimentation with uses outside of the classroom oftentimes led directly to innovative uses in the classroom, as was the case for a senior who downloaded “Pocket Millionaire” and helped his teacher prepare testing materials for the game to use with her

\textsuperscript{13} Students who did not take the handheld computers home were still able to use them for study by using them during free periods at school.
class. During our site visits, several students reported that they enjoyed sharing their discoveries with their teachers, and teachers often encouraged students to experiment. In one classroom, students reported in an interview that showing the teacher what kind of uses they were discovering enhanced the rapport between teacher and students.

Teachers whose students took the handheld computers home tended to report that certain tool management issues were less of a challenge. They were less likely to report that charging and battery life was a challenge (14 vs. 19 teachers). They were also half as likely to report that handheld computer use limited classroom time (9 vs. 18 teachers). This is consistent with our observations; we saw classes where students took just a moment to get their handheld computers out of their bags, and classes where students lined up for minutes to obtain, or return, their handheld computers.
Section III. Potential Benefits

The SOI Program demonstrates many potential benefits that the Mindsurf tools afford students and teachers within diverse school contexts. Across grade levels, disciplines, student performance levels, socio-economic status, geography and ethnicity, the participating teachers and students identified a number of potential benefits that the tools brought to their teaching and learning experiences. In addition, the evidence we collected over the course of the formative evaluation both supported and supplemented the potential benefits that students and teachers described. The data we gathered suggest that the Mindsurf tools offer considerable promise in addressing the company’s four goals to 1) provide teachers with the means for frequent assessment of student work, and provide students with ready feedback, 2) help teachers tailor their instruction to students’ needs, 3) offer high-quality instruction and interaction for all, and 4) support effective classroom management. In addition, the data suggest that the Mindsurf tools may help strengthen the school community.

This section presents detailed descriptions of the potential benefits within the framework of Mindsurf Networks’ four goals based on our observations and responses to the Web survey questions about the benefits of the handheld computers (see Figure 4).

A Note about Technology

Although research into educational technology repeatedly has demonstrated that electronic media are merely teaching and learning tools — not ends in themselves — this study took into consideration the unique attributes of the technologies upon which Mindsurf Networks relied. Because two central characteristics of the Mindsurf tools are mobile computing and wireless network access, we paid close attention to the potential benefits that constant access to computing and network resources afford teachers and students throughout the class and throughout the day. In addition, we paid attention to the value that SOI teachers and students gave to the pocket PC platform and the handheld computers — in this case, Compaq iPAQs — running it. Teachers and students often reported that the CE operating system and handheld computers offered several advantages over computing platforms and machines. Among the positive features that they mentioned were the following:

- An interface similar to desktop computers;
- More fully functional Word, Excel and Internet Explorer applications without the need for additional software purchases;
- More functionality with voice recording and multimedia;
- Multitasking capability;
- A high-quality display that improves Web and multimedia work;
- The possibility for schools to purchase lower cost handheld computers, e.g., a monochrome iPAQ.
Provide Frequent Assessment and Ready Feedback

The first area of potential benefit of the Mindsurf tools is support for both student assessment and teacher feedback. Potential benefits in this area include: increasing the opportunity for frequent assessment and new forms of feedback, and making assessment and evaluation easier.

*Increasing the opportunity for frequent assessment and new forms of feedback*

Because of the multimedia, networked nature of the Mindsurf tools, teacher feedback can be more frequent and tailored to student learning styles. Seventy-two percent of SOI teachers reported that they “agree” or “strongly agree” that the handheld computers “makes assessment and evaluation of student work more convenient, by allowing the teacher to carry student work in the handheld computer.” For example, one teacher
commented that she is able to give more feedback to student work and give feedback more quickly when it is submitted electronically rather than on paper. SOI teachers also reported that the Mindsurf tools, because of their electronic nature, increases the frequency of their feedback. (Seventy percent of Web survey respondents either agreed or strongly agreed to this question.) Furthermore, sixty-eight percent of SOI teachers reported that the handheld computers increase the quality of the feedback they provide students through audio and typed responses.

*Making assessment and evaluation easier*

Certain features of the handheld computers facilitate an easier and more efficient means for teachers to assess and evaluate students. Forty-one of the SOI survey respondents indicated that they “strongly agree” and 31 percent indicated that they “agree” that the tools make assessment and evaluation easier. (On the other hand, teachers using class sets commented that the inability to protect student work from other students who share the handheld computer limited their ability to use the tools for certain types of assessment.) Teachers created online tests that the students accessed via their handheld computers, or created tests and assignments that they could either beam or email to students. In this way, they were able not only to maintain a paperless environment, but also to keep all of the student evaluations in one place once they were completed. We observed two Language Arts teachers — one at a high school and one at a middle school — using the Web site Funbrain.com to assess student knowledge. The high school teacher used Funbrain.com to evaluate the students’ knowledge of poetry terms before beginning a poetry unit. The teacher commented on the convenience of receiving the test results via email. We also observed an Algebra teacher who used the Notes application to make homework assignments that she could then beam to students. By creating the assignments in Notes, students were able to write rather than type the process through which they went to work through each Algebra problem. This allowed the teacher to evaluate each student’s work, eliminating any concern for plagiarizing, and streamline grading.

**Help Teachers Tailor their Instruction to Students’ Needs**

The second area of potential benefit is support for the teachers’ ability to tailor their instruction to student needs. Potential benefits in this area include: providing greater flexibility in tailoring instruction, providing a means for giving greater individual attention to students, and improving learning opportunities for special needs students.

*Providing for greater flexibility in tailoring instruction*

There are two ways in which the Mindsurf Networks tools provide flexibility in shaping instruction. First, they have the potential to facilitate the fine tuning of instruction when addressing particular teaching points. We observed several classes where something such as immediate individual access to the Internet allowed students to engage in an activity that would have been difficult or impossible otherwise. In one middle school class, students formed collaborative groups, went online, and constructed “thinking maps” of different aspects of Hoof and Mouth disease after they began asking questions about a Channel 1 article they had viewed.
Secondly, as almost three-quarters of the survey respondents indicated, the use of the handheld computers facilitates the tailoring of instruction to better suit individual students’ needs. For example, in several classes, teachers capitalized on the variety of ways in which students could do something as simple as note-taking, allowing students to make decisions about how they would perform a task. As one SOI survey respondent wrote, “These handheld computers are absolutely fantastic as they open doors for all children to learn in a variety of ways.” As a second example, in one middle school science class the students could write, type, voice record or draw the information. By choosing how they wanted to complete a given task, the students were able to complete the task in a way that best suited their learning needs. Sometimes the option of providing students with multiple points of entry into an assignment resulted in greater student participation. As another SOI teacher stated, “Students who normally do no work at all, will complete an assignment on the handheld computer. I’ve had more options on ways to do things in the classroom with the handheld computers.”

**Providing a means for giving greater individual attention to students**

A corollary to providing greater flexibility in tailoring instruction is the opportunity to provide students with individualized attention. Just as teachers were able to use the tools to address a variety of student learning styles, several teachers reported that they also were able to have more frequent one-to-one contact with students. For several teachers, personalized email messages and voice notes attached to student work allowed the teacher to respond to student work while providing individualized attention to the students. If given time, the tools also support teachers’ individualizing of lesson plans or course materials. The availability of numerous, rich resources afford teachers the ability and the freedom to assign various tasks to students working at different paces. Students that either finish work early or are in need of modified instruction often demand the teacher’s attention. While this includes all students, it is especially true for young people in special education, general education, those who have disabilities that affect their learning processes, as well as those in Gifted and Talented programs.

**Improving learning opportunities for special needs students**

Half of the survey respondents said that they “strongly agree” and 33 percent reported that they “agree” that the Mindsurf Networks tools have the potential to improve learning opportunities for students with special needs. One way that the Mindsurf tools may help provide learning opportunities for special needs students is in helping to fulfill the goals outlined in Individualized Lesson Plans (IEPs). The majority of students with special needs have IEPs developed on the school site, and the teachers of students with special needs are supposed to modify instruction, expectations, and learning goals in accordance with the student’s IEP. For the parent of one learning disabled boy, the handheld computers helped the school meet the particular educational needs that she had fought to get for her son. This also built the parent’s confidence in her son’s school, strengthening the school-home connection, as mentioned above. In her words, “this was a sign that the school was willing to look after my son.”

Another way that the Mindsurf tools may help provide learning opportunities for special needs students is, as mentioned above, by providing a variety of ways in which students
can complete assigned tasks. For special needs students, the electronic environment may help focus their attention and give them a variety of modalities within which they may work. For example, in one school, the teacher informed us that some of her resource students have trouble using a pencil to form letters. With the handheld computers, the students can type their work. With greater options for schoolwork, students with special needs have a greater degree of ownership over both their work and their learning. The variety of choices also allows for students who could not previously perform tasks to do so in other ways.

### Offer High-Quality Instruction and Interaction for all

The third area of potential benefit is support for high-quality instruction and interaction. Potential benefits in this are include: providing access to a wide range of resources, increasing student motivation, fostering a greater sense of responsibility and professionalism, helping students conduct close textual analysis, helping students learn how to learn, enhancing student writing, facilitating collaborative work, and helping students develop higher order thinking.

*Providing access to a wide range of resources*

Because of the availability of a rich array of primary and secondary resources found on the Web, a wireless networked classroom is no longer constrained by physical materials stored within the classroom or school, or by the availability of a limited number of computer labs. Sixty-nine percent of SOI survey respondents marked that they “strongly agree” and 25 percent that they “agree” that the tools provide greater access to Internet resources. When conducting teacher interviews, several teachers commented that, in spite of network connectivity problems, they believed that daily access to the Web for every student was invaluable for student learning. Through such ready access, students had a platform from which to practice research and Web search skills. This, in turn, influenced the curriculum; several teachers commented that increasing reliance on Internet research was leading them to teach skills for determining which sites contain authoritative and useful information. We also observed that constant access to the Internet afforded teachers with opportunities to bolster lesson plans using a resources previously unavailable to them on a regular basis. For instance, several teachers showed us images that they had downloaded, stories that they had found, or original documents that they had located on the Internet to incorporate into lessons.

*Increasing student motivation*

Almost unanimously, SOI teachers and students reported how motivating the Mindsurf tools are. As one survey respondent enthusiastically summarized, “It motivates students to learn!” Although the novelty of the handheld computers may wane at some point in the future, the excitement had not lessened by the end of the first semester of the SOI Program. Instead, many SOI teachers reported how students were able to remain focused and engaged throughout entire class periods, rather than losing interest after only a short time. For some teachers, the increased motivation that students experienced, especially those students who traditionally have not performed well, led to improvements in performance. One SOI teacher offered the following assessment of the merits of the tools:
“Final exam reviews became fun, informative and scores greatly increased from the previous years.”

_Fostering a greater sense of responsibility and professionalism_
Using the Mindsurf Networks tools may encourage more polished and professional work. This is supported by the survey, in which 94 percent of respondents indicated that they “strongly agree” or “agree” that this is a potential benefit, as well as by our interviews with students and teachers. Teachers reported greater professionalism on the part of the students, as the statement made by one SOI teacher indicates:

“I see them becoming professional. When we did holocaust presentations, they pulled their material from the iPAQs, and the majority were taking notes on the iPAQs, putting information in. They would say, ‘you’ll have to speak up, I can’t hear over the keyboard.’ Or ask, ‘how many people were in the camps?’ Or, ‘slow down, and repeat that.’ I didn’t do anything. Without the iPAQs, I would have seen fumbling with papers, students tired of writing…. They were in charge, more assertive.”

Similarly, students reported how using the handheld computers “makes me feel like a professional.” They also reported a shift in how they saw themselves in the eyes of the teacher: “[the teachers] are treating us with more responsibility” and “they think we’re more mature.”

The sense of responsibility and professionalism may be due to several causes. Students commented that the pressure of caring for the handheld computers, keeping them charged, protecting them from damage or misuse from their friends, and making sure that they are not lost or stolen made them feel more responsible: “It’s like you’re proving yourself [with the liability agreement].” “It’s a nice pressure, not too much.” Another possible cause is that students perceive the handheld computers as fun and want to use them more in their schoolwork. The aspect of “fun” came up repeatedly in interviews and in the survey. One SOI survey respondent wrote, “The students plainly care more about learning. The handheld computers make it ‘fun.’” Many students told us that it was fun writing on the handheld computers, and that the handheld computers were cute. In the words of one student, “you want your work to go with how cool the computer is.” Another possible explanation for students’ increased sense of professionalism is the simple fact that their work “looked” more professional. Both teachers and students frequently commented on how much they valued the keyboards and word processing software, which allowed them to go beyond illegible penmanship and produce revisions without creating “messes.” Similarly, email aided the way students and teachers were able to discuss student work samples; as an SOI teacher explained, “[Students] take great pride when their work is emailed as an outstanding example to other students as well as receiving individual emails from me.”

_Helping students conduct close textual analysis_
The Mindsurf tools provide opportunities for students to conduct close textual analysis of written and audio texts, and to create reflections and revisions of these reflections. Some
teachers, in particular those at the Development Schools, reported that this iterative process may lead to a higher quality of work and a deeper understanding of content. Moving away from their more traditional reliance on textbooks, and information that already has been interpreted and edited by the textbook authors, SOI teachers were able to make greater use of primary sources on the Web. For example, a middle school teacher in the Midwest assigned her students the task of creating travel brochures for cities in their home state. Once students selected the town or city on which they would focus, they sifted through maps, Chamber of Commerce materials, ecological information and other resources they found on the Web.

Helping students learn how to learn
Eighty-five percent of the survey respondents reported that they “agree” or “strongly agree” that the SOI Program helps students learn how to learn. Teachers wrote that the handheld computer use offered “self-directed learning opportunities,” and that the “children are highly engaged in their learning.” Of course, the ability of the Mindsurf tools to support inquiry-based learning, in which students find answers by developing their own questions and learning strategies rather than following those of the teacher, depends on the pedagogical orientation of the teacher; handheld computers and wireless networks also can support more traditional pedagogy. However, immediate and consistent access to the Internet is a useful vehicle for teachers to employ inquiry-based learning strategies and may lead to student-directed activities. For example, in a high school Environmental Studies class, students researched on the Internet to find support for their pro- and anti-nuclear positions, then created a propaganda poster promoting their position on the issue. The students explored the issue based on questions they developed and had the freedom to pursue information in varied degrees of depth and breadth. They also had to coordinate with their partners to determine whether their evidence suited their purpose.

Enhancing student writing
SOI teachers reported that the Mindsurf tools encourage students to write more, encourage better organized student writing, and helps them to revise their work. In the survey, 57 percent “strongly agree” and 31 percent “agree” that the Mindsurf tools encourage students to write more, and this was strongly supported in many student and teacher interviews. Teachers, across a variety of grade levels and subject matter, also commented that student writing was of a higher quality than before the implementation of the project. One SOI teacher concluded, “[Students] seem to concentrate more when they are working on their assignments. They seemed more eager to try different writing assignments.” Another teacher reported that he was seeing better sentence structure, more description, and more thorough revisions. Several teachers also reported that the students seem to enjoy writing more because they value the professional aspects that word processing allows them. Students confirmed this by saying that they liked writing on the computers more than with pencil or pen and paper. “The words just flow out of your fingers,” said one student.
Facilitating collaborative work

Over ninety percent of the survey respondents reported that the tools facilitate collaborative work. There are myriad ways in which the tools can support collaboration — among students, between the teacher and student, and even among SOI teachers. During our site visits, we saw groups of students communicating and sending information via email or infrared. Several SOI teachers also used the tools to facilitate more sharing of individual student work. Students could either share their work by physically passing their handheld computers to one another, or by sending it electronically. In this way, students could collaborate on ideas, and revise and offer feedback on one another’s work.

Just over half of the survey respondents (51 percent) indicated that they had assigned independent or group research projects before they implemented the tools in their classroom, and for these teachers the tools may enhance their ability to promote collaborative work. One teacher said that she had always been a collaborative-style teacher, and that the tools made it that much easier to encourage student collaboration. In her class, we observed students forming a variety of groups on their own and using the handheld computers in a number of ways within those groups. According to the teacher: “Students are more independent now. They say, ‘leave me alone. I’m interested. I don’t want to stop.’” For other teachers, the tools support collaborative work that might not have been feasible before. One teacher, commenting on a jigsaw activity in which students collaborated on a research assignment, said: “I couldn’t have done this last year.” For her, the handheld computers streamlined the process of comparing notes and combining information for the students’ presentations.

Helping students develop higher order thinking

Several teachers and principals commented that, while it may be premature to expect improvements in test scores, they were confident that the Mindsurf tools could improve higher order thinking skills. In the words of one principal, “The regular curriculum doesn’t require kids to expand. We’re not teaching them to be problem solvers. … The iPAQs can help with not just scores, but to teach things they normally wouldn’t do in the classroom. To see a problem and solve that problem.” Although this opinion is in sharp contrast to others we heard voiced by administrators that all they ultimately value is a rise in student test scores, some principals and teachers perceived a noticeable change in students’ ability to formulate questions, conduct research, synthesize and analyze data and make cogent arguments.

Support Effective Classroom Management

The fourth area of potential benefit is in supporting effective classroom management. Potential benefits in this area include: providing portable computing, making class work more efficient, and improving student organization.

Providing portable computing

The Mindsurf tools allow for nomadic computing, giving students continuous access to a suite of applications, Internet-based resources, and class documents as they move around the classroom, among classrooms in the school, and between the school and home or
other locations. Seventy-five percent of the survey respondents said that they “strongly agree” and 24 percent said that they “agree” that portable computing is a potential benefit. During our visits to the SOIs, we observed several occasions when teachers and students capitalized on the portability of the handheld computers both inside and outside of formal classroom instruction. As an example of in-class portability, students in one high school English class peer-edited each other’s work by passing their handheld computers to the student sitting behind them. In a demonstration of portability outside the classroom, three middle school biology classes at one school studied biodiversity in groups by writing, recording, and drawing observations of grassy plots in a field next to their school. Once they had recorded the information on their handheld computers, the students beamed the data to the other members of their group so that they could combine and compare their data. Portability also extended beyond the school grounds. Students brought their handheld computers home to complete homework, studied Shakespeare during ballet class, wrote school newspaper articles from a robotics championship in a city halfway across the country from their school, and communicated with a busy doctor during their hospital internship.

Making class work more efficient
The majority of the SOI teachers reported that the Mindsurf tools have the potential to make their class work more efficient. Forty-nine percent of the survey respondents indicated that they “strongly agree” and 27 percent indicated that they “agree” that this is a benefit afforded by the tools. There are several ways in which the tools support more efficient class work. One is the support for a paperless environment. For example, one teacher commented that it is easier for him to take the students’ work home on the handheld computer instead of taking home a box full of papers each night. Another is that, rather than supplying each student with a photocopied handout, the teacher can use the computers to email or beam a template to students. In the words of one teacher, “My Xerox number is going down.” A third is that, once SOI teachers cleared away any hardware and classroom management obstacles that faced initially, they reported that distributing class assignments — both between teacher and students and among students — occurred at a faster pace, leaving more time to discuss the substance of student work. As one SOI teacher reported after using the Mindsurf tools for a short time, “I was able to accomplish so much more in the two weeks that we were able to use them.” And lastly, SOI teachers reported that the immediacy of being able to use the Web resulted in greater efficiency. “Students can now work on assignments immediately,” explained one Web survey respondent, “instead of waiting for next available computer.”

Improving student organization
One byproduct of the paperless classroom is improved student organization. Several students and teachers reported that working with electronic handouts kept students more organized and made it more difficult for students to lose or misplace class materials. In addition, with the personal calendar, the task reminder function, and the capacity for organizing documents into folders, students were able to use the tool as a vehicle to organize not only their class work but also their personal affairs. Forty-nine percent of the survey respondents indicated that they “strongly agree” and 47 percent indicated that they “agree” that the tools have the potential to improve student organization. During student interviews, numerous students reported that they had replaced their day planners with
their handheld computers, recording all of their homework assignments, ‘to do’ lists, and appointments in their computers. In interviews, several teachers told us stories about individual students who before the addition of the Mindsurf Networks program had been disorganized to the point where it interfered with their school work. The teachers claimed that the handheld computers, with their various organizational functions, had motivated the students to bring order to their lives.

### Strengthen the School Community

In addition to the support we found for Mindsurf Networks’ goals, we found evidence of potential benefits that can be generally understood as strengthening the school community. Potential benefits in this area include: reshaping administrator’s technology vision, encouraging professional development, shifting traditional student/teacher roles, and strengthening the home-school connection.

### Reshaping administrator’s technology vision

The potential benefits of the portable, wireless computing model influenced several administrators’ vision for educational technology at their schools. Some reported that they wanted to adopt a wireless handheld model as part of their overall technology plan during the next year’s round of budget discussions. As one teacher survey respondent wrote, “This is just incredible technology! Parents, students, and teachers are all impressed and positive about it’s [sic] capabilities and the possibilities for learning. Our district is focusing on the integration of technology as one of our goals for 2001-2002 school year. Hopefully, we will have a referendum in the fall for additional technology money.” Although most of the principals and other administrators we interviewed reported that they were taking a “wait-and-see” approach — they wanted to learn more about the benefits of the Mindsurf tools before allocating resources that would allow their school to go beyond a single class use — they were willing to reconsider how their technology plan could be altered to accommodate more than the computer lab model. Overall, this project provided administrators with a means for considering how to adapt the school’s technology infrastructure to meet the needs of teachers and students.

### Encouraging Professional Development

As the Mindsurf Networks project included new and dynamic educational technologies, several teachers indicated that they would like to participate in on-going professional development regarding innovative ways in which to integrate the handheld computers into their curriculum. “Now that I am using this in so many ways I cannot [imagine] going back to the art of teaching without these.” Although there was no follow-up training beyond the initial session that SOI teachers attended, participants reported that they felt valued and respected and were eager for additional opportunities to grow as professionals.

### Shifting traditional student/teacher roles

The Mindsurf tools create opportunities to invert the traditional power dynamic between teachers and students, giving some students the opportunity to teach or shape lessons and knowledge. Forty-three percent of the survey respondents said that they “strongly agree”
and 31 percent that they “agree” that the program shifts traditional student/teacher roles. During our observations and teacher interviews at the schools, we observed this happening in a variety of ways. In many cases, the teachers — many recognizing that the students were more competent technology users than they were — looked to the students to act as leaders or take on a considerable amount of responsibility within the project. The technology thus created an arena in which the students could take charge and demonstrate their expertise. At the Development Schools, in particular, and at some of the SOIs, teachers chose a group of students to act as technical assistants handling and managing all of the equipment, and or, troubleshooting when individual students were having problems.

Some teachers also discussed how the implementation of something so new and experimental bonded them with their students. A SOI survey respondent wrote, “They enhance a positive relationship between teacher and student and I find students become very comfortable with sharing information or asking questions that they might not ask in class.” In an interview, a group of four students told us that because both they and their teacher were so excited about the program, they enthusiastically shared their day-to-day discoveries with one another, ultimately improving the rapport between teacher and students. One of those students said, “He loves the computers and so do we. It makes a connection.”

**Strengthening the home-school connection**

The Mindsurf tools may strengthen the home-school connection in several ways. In interviews and comments that parents wrote during school meetings, parents mentioned the greater attention they are giving their school as a result of the SOI Program. This was partly a result of the liability concerns they had about losing an expensive set of tools, and partly a result of pride and renewed confidence in their school for being at the forefront of educational technology. One parent said that she felt “proud that this school was chosen.”

The tool also may strengthen the connection between parents and their children around schoolwork. Parents indicated that there is more interaction with their children about schoolwork, and commented on the improved organization and the responsibility that their children were demonstrating. This change in parent involvement also was not overlooked by the students. For example, one student reported that his parents would ask “What did you do with the iPAQ today?” Students also are more eager to share their schoolwork with their parents; one parent said that her daughter shows her what she did in school that day and shows her brothers how to operate the handheld computer. Finally, at several schools, learning disabled students found that the handheld computer makes it easier for them to complete their schoolwork and to share it with their parents.
Section IV. School Case Studies

Five case studies are presented to highlight themes that CCT researchers found throughout the site visits. These case studies provide examples of the range of issues that schools faced during the initial phases of tool integration. These case studies are not intended to provide a comprehensive account of themes we found from our research, nor is each case study meant to represent a particular challenge or potential benefit. Instead, these case studies offer snapshots of how individual teachers adapted the Mindsurf tools to their classroom practices, and how they and their students developed innovative approaches to teaching and learning.

Case Study 1: River Hill High School
River Hill High School is one of Mindsurf Network’s two development schools. At River Hill High School – a majority white school that is the only high school in the state of Maryland to receive outstanding ratings in all areas of the educational state report card – teacher Jane McNeil incorporated the Mindsurf tools into the performance assessment for her eleventh grade Gifted and Talented English class. The performance assessment was a simulated courtroom trial based on *The Adventures of Huckleberry Finn*, and students used the Mindsurf tools to research and perform their roles of judge, prosecutors, defense attorneys, witnesses, jurors, and Huck. The attorneys read questions from them as they paced the classroom, their colleagues accessed information on the Internet that might be used during a line of questioning, witnesses stored information about their characters, and jurors typed notes on the keyboards during testimony.

McNeil believes that the portability of the handheld computers, which students could carry in their hands as they moved about the room, increased the amount of information available to them and freed them to interact fully in the trial. They also could tailor the different capabilities of the handheld computer for the purposes that best suited their role in the trial: jurors took notes on them; witnesses accessed information about their character from the book; lawyers read questions off the screen; teams checked information they had stored, and students used the tools for on-the-spot research. At one point, the prosecution went on-line during the trial to find the Missouri State statutes in order to pursue a line of questioning. The use of the handheld computers also facilitated collaborative work; students beamed each other information during the trial, and one group communicated via Instant Messenger, which they had downloaded onto their handheld computers.

Case Study 2: Hamilton Middle School
Hamilton Middle School is the other of Mindsurf Network’s two development schools. The school, in northeast Baltimore, has 1100 predominantly African-American students, the majority of whom read on a third or fourth grade level. In Catherine Preston’s seventh grade science class, 25 of the 38 students have Individualized Education Plans (IEPs), indicating that the student is either “at-risk” or has a processing disorder or disability. During one class, Preston suggested that students use the handheld computers however they wished to respond to a video about insects in their natural habitats. They could take the notes using their collapsible keyboards, draw pictures or diagrams, or record voice reflections. Some of the students whispered their thoughts into the voice recorder, some
wrote sentences, and others drew insects in their habitats on their computer screens. When asked if anyone wanted to share information that they found interesting, one student with a language processing disorder gave a stilted but proud reading of his two sentences, another eagerly held up the computer so that everyone could hear what she had recorded, and another walked around the room showing his depiction of ants on the handheld screen.

Preston believes that the handheld computers support a classroom in which students construct meaning. She feels that the tools improve opportunities for special needs students, who are able to write more with the handheld computers and hence experience more success. She can tailor her instruction to their various learning styles, for example allowing students to document their observations of the video in different ways. The portability of the computers also facilitates sharing and collaboration; by beaming, emailing, passing their computers to one another, or walking around the classroom showing other students the work on their computer screen, the students can share their ideas with one another. Finally, Preston says that the tools grant the students a greater sense of responsibility and professionalism, making them feel as though they are completing work, as one student said, “in a modern and mature way.”

Case Study 3: Lakeside High School

Lakeside High School is a largely white school of 1650 students in a middle to upper-middle class section of a Southern town. It is a high-performing school, chosen by the state as a “School of Excellence” for the overall quality of its course offerings, staff development, and community involvement. George Townes, a teacher for eight years, has embraced technology in his teaching; he is a district technology mentor and teaches an online class. In his twelfth grade English class, his students wrote letters from the perspective of characters in Romeo and Juliet, beamed them to each other, and responded to the letters. The class has also been working on descriptive writing. Students edited a “description sample” that Townes had beamed to them, using different font colors to differentiate their editing from the original, and then sharing their revisions and discussing writing concepts, such as “show, don’t tell.” In another activity, students wrote descriptions into an Excel “sensory chart” of a photograph of a diner, based on the five senses, which they then used to build a paragraph.

Townes sees greater access to online resources encouraging a greater sense of responsibility and professionalism: “They’re making sense of their own education, and everyone is coming away with something different. It’s no longer ‘look at this on the board.’ It’s everyone exploring.” For example, one girl downloaded a copy of Romeo and Juliet from the Internet. After marking and indexing her lines in the Ereader, she was able to study whenever she had time, including during her ballet lessons. Students also say that they write more, write more detailed work, and edit more with the handheld computers; Townes agrees: “Usually they stop writing after a while, but with the iPAQs, no. There is better sentence structure, description, and they are more likely to revise.” For example, when discussing the Romeo and Juliet letters, students explained that “to write

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14 To protect anonymity, we changed the names of the schools, administrators, teachers, and students in the three SOI case studies.
a letter you really have to understand the play,” and that “you have to incorporate… to know that point of view.” Finally, Townes sees working with the Mindsurf tools as an opportunity for professional exploration; he has developed email correspondence with another SOI teacher, and improvises with the handheld computers in the class. His professional excitement spills over into the class; the students say that it is partly because Townes is excited about the possibilities of new technologies in his teaching that the students can share that excitement: “he loves those computers, just like he loves us.”

Case Study 4: Palms Middle School
Palms Middle School is located in an area of government subsidized housing, trailer homes, and projects in a large southeastern city. The students at this school represent the lowest socio-economic class of any middle school in the county. This is “not an easy school,” in the words of teacher Elizabeth Wheeler. The school has an extensive technology infrastructure, and the school sees technology as an important tool to help poorer students compete in the job market, as well as a central lever to attract students to the school. Wheeler has been using the Mindsurf tools with her advanced seventh grade geography class. She is “big on collaboration,” and she welcomes the handheld computer’s ability to support collaborative research. She has involved her students in a collaborative, Webquest-style, research project, and has had students collaborate to research online and answer worksheet questions about the Tuskegee airmen. She is looking forward to learning more about teaching with the handheld computers, and she also encourages innovation from her students. For example, early in the project some of her students asked for permission to use a chat room they found on the Internet, and she is interested in seeing how they use it.

Wheeler sees a shift in teacher and student roles; at the same time that she is trying to learn all she can about the potential of the Mindsurf tools, students often explain to her aspects of how to use the Mindsurf tools. She says that this is good for the students, even if it makes her feel “a little out of sorts.” She also sees improved student organization. When an assignment is due, the students pull out the handheld computer and do not have to worry about losing papers. She is amazed by the wide range of resources the handheld computers and wireless network make available to her students. Class work, such as the World War II research activity, could not have been done before without a visit to the computer lab. They are also examples of how the tools support collaboration and different learning styles: during our site visit, one group wrote answers for the Tuskegee airmen activity on paper so that the worksheet remained on screen; another group copied and pasted the worksheet into a Word document and wrote the answers in red; in another group, a student asked the questions, another student searched for the answers on the Web site, and the third student typed the answers. Finally, the handheld computers have opened up possibilities for Wheeler’s professional development. She has been regularly emailing a Mindsurf teacher in a nearby school, and has gone to her house to learn how to sync. After just over one month of handheld computer use, she already is developing a long-range vision and is quick to discuss possibilities for the future. Still, she feels that she has only begun to explore the possibilities for the handheld computers and wireless network: “Teachers can get comfortable with what they are doing… it requires me to think outside the box to use the handheld computers in the lesson.”
Case Study 5: Baker Middle School

Baker Middle School is an above average performing school of approximately 600 predominantly white students, in a small Midwestern town. Principal Marlow is interested in the role of technology at his school, and wants to increase its role, but is limited by a lack of funding. The Mindsurf teacher, Barbara Walker, a teacher for 25 years, is self-taught when it comes to technology. Walker uses class sets – handheld computers shared by her three seventh grade language arts classes – to integrate handheld computer use into a variety of class activities. For example, a discussion about The Confessions of Charlotte Doyle led to the character sketch writing activity using the handheld computers. Walker also has created a Charlotte Doyle reader’s guide in Ereader format to substitute for projecting her handwriting on the meager wall space in the front of the class. Additionally, Walker has used recorded annotations to provide feedback to student work, and reported that using voice notes not only allows her to provide more feedback than if she wrote her comments, but also adds a personal element and individual attention that the students appreciate.

Walker finds that the use of the Mindsurf tools have allowed for more productive instruction time; students do not have to wait for access to a computer and the Internet. Students report that they write more with the handheld computers than they do on paper, because writing with the handheld computers is “funner,” and because the end product is more satisfying and professional looking. The students also say they are more independent in finding information. For example, in a research assignment on the Titanic, students identified questions that were not answered in their reading, then used Internet resources to find answers to them. The tools may also improve learning opportunities for special needs students. Several learning disabled (LD) students commented that using the handheld computer provides a private space for them to express themselves and a sense of safety that encourages them in their work and in their communication with the teacher. One LD student said he was now more motivated to engage in the school work; he didn’t worry about being embarrassed or feign illness to avoid school, as he had done in the past. For another LS student, his new-found abilities has increased his sense of the options available to him: “I wanted to be a computer dude, but didn’t think I had skills. Then I wanted to be a forest ranger, but that also requires computers skills. This is boosting my self-esteem.” Because his writing is more complete and legible now, he is sharing his writing now with his mother: “I like writing stories…Before, I would give my mom my stories and she couldn’t read them. She would ask what they were. I’ve been giving her these and it’s been helping me. Now she has a box full of stories and she keeps them. She tells me that she is going to give them to me when I’m older.”